The Biology of the Benthopelagic Component of the Shallow Scattering Layer

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LONG-TERM GOALS

Each night, animals (particularly crustaceans) swim out of the seabed into the water column, a phenomenon termed "emergence." The distribution of these optical and acoustic scatterers is not well known in time and space. The cues that trigger the behavior, the environmental factors that modulate it, and the underlying ecological mechanisms that drive it are just beginning to be elucidated. My long-term goal is to understand this phenomenon to the point that variation in space and time are predictable and mechanistically understood.

OBJECTIVES

My main objective during this funding cycle has been to develop an isokinetic sampler that will allow me to collect small (~0.3–1.0 mm), emerging animals quantitatively from multiple heights simultaneously at short time intervals. Such a sampler is the key to resolving the spatiotemporal variability of emergence. My second objective has been to investigate the ecology of the small emergers at the site studied during the SAX99 experiment of the Benthic Acoustic DRI.

APPROACH

My approach to the design of the isokinetic sampler was (1) to determine the constraints that the biology imposed (for example, the volume of a sample must be large enough to collect sufficient animals for statistical tests), (2) to consult with a fluid dynamicist (Dr. Doron Nof, Florida State University) about design criteria for isokinetic sampling, (3) to prepare working drawings (with help from a Senior Design Team from the FSU College of Engineering), (4) to arrange for the construction of a prototype by a machinist in the FSU Department of Oceanography, and (5) to test the prototype.

My approach to the investigation of the small emergers at the SAX99 study site was to perform an emergence-trap experiment when the Benthic Acoustics DRI investigators were active on the site. With these samples, a graduate student (Linda Gensel) and I are determining which species emerge and testing hypotheses about commonalities among emergers that might be used to predict the identities of emergers in other environments. We are also comparing emergence from ripple crests to that from ripple troughs to begin to understand spatial variability in emergence. In addition, some of the acousticians involved with the Benthic Acoustics DRI are interested in the properties of the small emergers. I plan to forward information to them on size, shape, and abundance.

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14. ABSTRACT

Each night, animals (particularly crustaceans) swim out of the seabed into the water column, a phenomenon termed ???emergence.??? The distribution of these optical and acoustic scatterers is not well known in time and space. The cues that trigger the behavior, the environmental factors that modulate it, and the underlying ecological mechanisms that drive it are just beginning to be elucidated. My long-term goal is to understand this phenomenon to the point that variation in space and time are predictable and mechanistically understood.

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WORK COMPLETED

During FY 2001, a Department of Oceanography machinist and I have been developing and testing components of the new sampler. The pumping system, the sampling system, and the intake-head assembly have been successfully tested in the ocean. All that remains to be developed is the supporting structure. It has been designed and will be built and tested during summer and fall 2001.

During FY 2001, the student identified the animals from the SAX99 emergence experiment and began the data analysis. She will complete this work and defend her master's thesis during fall 2001. She will continue for her doctorate under my supervision. We anticipate several publications from the SAX99 work.

RESULTS

The development of the isokinetic sampler is nearly complete. The major technical result during FY 2001 was the discovery of a system that would allow the intake head to rotate in water that is filled with small particles that cause conventional bearings to bind.

The major results of the SAX99 emergence experiment include the following. (1) Small animals emerge in abundance in the high-energy environment of the SAX99 site, so their emergence is not a phenomenon of slow-flow environments as had been suggested. (2) Previous workers have tended to view emergence as an all-or-nothing phenomenon. The SAX99 results show that emergence rate (percent that emerge in 24 hrs) of species can vary from 2% to 100% (Figure 1). That different species emerge in very different proportions suggests that a single mechanism does not underlie the phenomenon. (3) Percent emergence tends to be greater in the troughs than on the crests of sediment ripples, indicating that emergence is not spatially homogeneous and can be modified by environmental features (Figure 1).

IMPACT

The development of an isokinetic sampler scaled for use with 0.3- to 1.0-mm animals will be of great value in the study of emergence, but it should also be of use to students of other organisms in this size class, e.g. the larvae of benthic animals.

TRANSITIONS

The information on the size of small emergers is being used to refine the acoustic models of Drs. Greenlaw, Holliday, and McGehee.

RELATED PROJECTS

Dr. Peter Jumars is also studying emergence in the context of the Benthic Acoustics Initiative. He is concerned with larger emergers (>1.0 mm), which are taxonomically distinct and must be sampled with different techniques. We are working closely together to coordinate fieldwork and to share ideas about the emergence phenomenon.

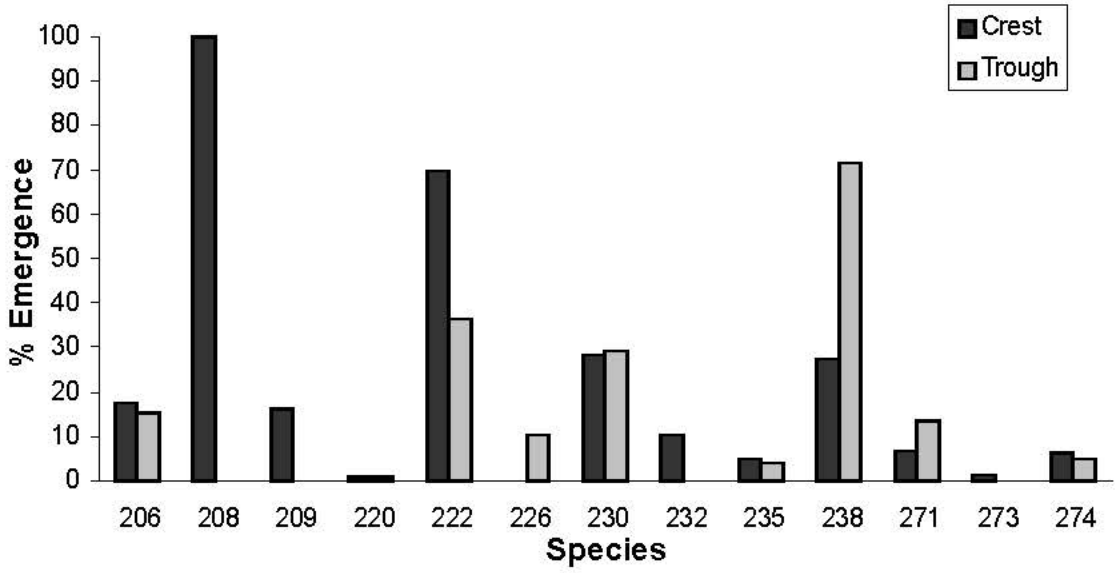

Figure 1. This graph shows that benthic copepod species at the SAX99 study site emerged in percentages that varied from 2% to 100% and that emergence of a single species at sediment crests and can differ from that in sediment troughs.